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Influence of storage containers, desiccant on physiology of summer groundnut (*Arachis hypogaea* L.) cv. G2-52 stored both in the form of pod and kernel during storage

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Abstract
An experiment was conducted to assess the physiological performance of groundnut (*Arachis hypogaea* L.) in storage during 2016-2017 to evaluate the influence of storage containers and desiccants on longevity of groundnut Cv. G2-52. The groundnut is stored both in the form of pods and kernels, and they were stored in four different packaging materials like PICS (Perdue improved crop storage) bag, HDPE (High density polythene bag) bag, polythene bag (700 gauge), and gunny bag. Among the interactions T1 (pod stored in PICS bag) showed maximum seed quality parameters like germination (81.17%), seedling dry weight (294.7 mg), dehydrogenase activity (0.440 OD value) with lowest electrical conductivity (dS/m). Whereas the lowest germination (55.17), seedling dry weight (131 mg), dehydrogenase activity (0.142 OD value), with highest electrical conductivity (1.410 dS/m) were recorded in T14 (kernel stored in gunny bag) at the eight month of storage period.

Keywords: Physiology, summer groundnut, *Arachis hypogaea* L. kernel

Introduction

Groundnut (*Arachis hypogaea* L.), is "king of oil seed crops", is believed to be native of Brazil (South America). Groundnut is also called as wonder nut and poor men's cashew nut. Groundnut is also called as "Poor man's almond" because of high oil content (44-50%) and protein content (25-35%). It can supply about 5.6 and 5.8 calories per gram of kernel in the raw and roasted form respectively. In addition it contains 18 per cent carbohydrates. It is also a good source of minerals (Ca, Mg and Fe) and vitamins (B1, B2, E and K) high nitrogen content (7-8%) and other nutrients. It is a richest plant source of thiamine and niacin, which are low in cereals. It's a leguminous crop and thus fixes a large amount of nitrogen and improves the fertility status of soil. The plants, kernels, shells, oil and cakes are economically used in one or the other way.

Seed is a living organism and aging is an inevitable process beyond the physiological maturity whether the seed is in the mother plant or in storage. This process can be controlled to some extent by adopting suitable techniques and improved storage methods and some innovative technologies.

Seeds being hygroscopic in nature, viability and vigour of seeds are regulated by variation in storage containers, initial seed quality, packaging conditions, physicochemical factors etc. (Doijode, 1988) [3].

Groundnut is one of the poor storer. Storing seeds after harvest till the next cropping season without impairing the quality is of prime importance for successful seed production. Being an oil seed crop groundnut seed has short life and looses viability quickly under ambient conditions. Ageing in groundnut seed leads to increased lipid peroxidation, decreased activities of several free radical and peroxide scavenging enzymes (Rao *et al*., 2006) [9]. Groundnut seeds are more sensitive to storage conditions like high temperature; high seed moisture content and light exposure. The qualitative loss of seed can be attributed to biochemical changes in protein, carbohydrates, fatty acids and vitamins (Girish *et al*., 1972) [4]. The rate of ageing mainly depends on genotype, moisture and temperature. In rapid and slow ageing (natural ageing), the pattern of deterioration proceeding the death is the same whether seed survives for few hours or decades. Post-harvest food losses during storage are substantial and lead to various causes. Losses in stored cereals, pulses and oilseeds depend on the crop, the storage conditions and the type of post-harvest processing. Groundnut (*Arachis hypogaea* L.) is an important cash crop, rich in oil, protein and energy value. Sizeable post-harvest losses have been reported in groundnut, particularly during storage (IITA, 2000). Molds, pests, flavor changes, and rancidity are the major negative factors that affect groundnuts during storage. Physical deterioration of pods/seeds such as shrinkage and weight loss, are also common.

Materials and Methods

The storage experiment was conducted in the Seed Quality Research Laboratory of National Seed Project, Seed unit, University of Agricultural Sciences, Dharwad on "Effect of Packaging Materials and Forms on Storability of Summer Groundnut (*Arachis hypogaea* L.) Cv. G2-52" The experiment was conducted during the period of July 2016 to March, 2017. Seeds of groundnut Cv. G2-52 were obtained from the Seed Unit, UAS, Dharwad which were harvested from 2016 summer season. Both pod and kernel forms were used for storage studies. The pods were hand shelled and used for experimental purpose.

Four packaging materials were used for the experiment like PICS (P1-Perdue improved crop storage bag), HDPE bag (P2), polythene bag700 gauge (P3) and gunny bag (P4).

Description of PICS (Perdue Improved Crop Storage) bag used in this experiment

The PICS bag is a triple bagging hermatic technology consisted of two liners made out of high-density polyethylene (HDPE) and an outer woven layer of polypropylene that provides protection during handling. Together, these bags create a low-oxygen environment that reduces development of stored-grain insects (Murdock *et al.*, 2012) [7]. The critical differences were calculated at one per cent level of significance. The percentage data of germination were transformed into arc sine root transformation before analysis.

Description of zeolite beads used under experiment

Seed drying beads are modified ceramic materials (Aluminium silicates or "zeolites") that specifically absorb and hold water molecules very tightly in their microscopic pores. The beads will continue to absorb water until all of their pores are filled, up to 20 to 25 per cent of their initial weight. First moisture percentage of seed is calculated with the help of hygrometer for relative humidity and temperature.

Then required bead quantity to bring down at required percentage level of seed (4-8% for small and large seeds) was also calculated with the help of hygrometer. The amount of beads required for lowering the moisture percentage of seed depends upon several factors: i) the water-holding capacity of the beads; ii) the quantity of seeds to be dried; iii) the initial seed moisture content and iv) the final desired seed moisture content. After knowing the initial moisture content percentage of seed and the desired moisture content percentage, the required quantity of zeolite beads is calculated. In the present experiment the initial moisture content was 7.12 per cent. Hence, depending upon initial seed moisture content (7.12%) bead capacity are calculated in prescribed bead to seed ratio. *i.e* 110:1000 of zeolite beads are used to dry the one kilogram of groundnut seed to reduce its moisture content to 5 per cent.

Germination percentage

The standard germination counts were taken on 5th day and 10th day as first and final count. Total germination percentage was calculated on the basis of number of normal seedlings obtained in the final count expressed in percentage (Anon., 2011).

$$\text{Germination (\%)} = \frac{\text{Number of normal seedling Obtained on final count}}{\text{Number of seeds put for germination}} \times 100$$

Seedling dry weight

The same ten seedlings used for seedling length measurement were taken to determine dry weight of seedling. These seedlings were dried in hot air oven at 70ºC for 48 hours and dry weight of seedling was recorded and expressed in milligrams (mg).

3.5.10 Dehydrogenase enzyme activity

75 seeds from each treatment were soaked in water for 16 hours in three replications of 25 seeds each. Then seeds are cut longitudinally through embryo into two equal halves. Each half was placed into a beaker and add 0.25% aqueous solution of 2,3,4 triphenyl tetrazolium chloride just to submerge them. Then the beakers were kept at 40˚c for 4 hours. The seeds after turning to red colour should be washed well under the tap water and then 6 ml of 2 methoxy ethanol was added to each beaker containing 25 half seeds. After 10 hours when all stain was extracted from seeds the optical density of coloured solution was read at 470 nm and it is expressed in OD value (Bulat, 1993) [2].

Electrical conductivity (EC) test

Four replications of five gram seeds were weighed upto two decimal place. The seeds were surface sterilized with 0.1 per cent $HgCl_2$ for 30 seconds and were washed in distilled water and then soaked in 25 ml distilled water at 25 ± 1 ºC temperature for 24 hours.

Electrical conductivity of seed leachate was measured in the digital conductivity meter. After subtracting the electrical conductivity value of distilled water from the value obtained from the seed leachate, the actual electrical conductivity due to the leached electrolytes was measured and expressed in dSm^{-1} (Parsely, 1958) [8].

Results and Discussion

The results of laboratory and field experiments conducted during 2016-2017 with a view to predict storability of groundnut (*Arachis hypogaea* L.) through various parameters are presented below.

Germination (%)

The germination percentage did not differ significantly due to interaction of packaging materials, desiccants and forms throughout the storage period. During the storage period, the highest germination 79.33 per cent was recorded in T3, which was on par with T14(78.33%) and the lowest value was recorded in kernel stored in gunny bag without and with zeolite beads (48.33 and 50.67%, respectively) followed by pod stored in gunny bag without zeolite beads (58.67%) are presented in Table 1.Seeds stored in gunny bag showed rapid reduction in germination compared to slow reduction in other containers, which may be possibly due to pervious nature of containers to moisture vapour leading to greater fluctuation in moisture content and deterioration of seeds besides increased activity of storage fungi and pests, even though desiccant added to it due to pervious nature there was no effect of desiccant in gunny bag. The seeds stored with desiccant in moisture impervious containers showed slow reduction in germination percentage.

Seedling dry weight (mg)

The seedling dry weight did not differ significantly due to interaction of packaging materials, desiccants and forms throughout the storage period. During the storage, the highest seedling dry weight (294.7 mg) was recorded in T_3 which was on par with T_4 (290.0 mg). While, the lowest seedling dry weight was recorded in T_{14} and T_{16} (131.10 and 140.1 mg, respectively) at the end of ninth month of storage period are presented in Table 1.

The results obtained in this study showed that seed aging resulted in reduced seedling growth and this is a consequence of decline in weight of mobilized seed reserve (seed reserve depletion percentage). The results are in agreement with the findings of Mohammadi *et al.* (2011) [6] in soybean and Reddy and Biradarpatil (2012) [10] in groundnut.

Dehydrogenase enzyme activity (OD value)

There was no significant difference due to interaction of packaging materials, desiccants and forms throughout the storage period on dehydrogenase enzyme activity on seeds. During the storage, the highest dehydrogenase enzyme (0.440 OD value) was observed in T_3, which was on par with T_4 (0.421 OD value). While, the lowest protein content (0.142 and 0.152 OD values) was observed in T_{14} and T_{16} respectively at the end of ninth month of storage period is presented in Table 13c.

Generally the electrical conductivity of seed leachate values is related to membrane integrity and quality of seed. Higher, the electrical conductivity lower is the membrane integrity and seed quality and vice versa. In the present study, increased in electrical conductivity of seed leachate values was noticed with increase in storage period, irrespective of packaging materials. This might be due to non-leaching of seed metabolites from the seeds because of better membrane integrity compared to seeds stored in gunny bag which recorded the highest electrical conductivity. This higher electrical conductivity may be attributed to the increased leaching of metabolites from the seed indicating deterioration of seed due to high moisture. Similar results were observed by Krishnappa (1997) [5] in groundnut.

Dehydrogenase enzyme activity (OD value)

There was no significant difference with the interaction of packaging materials, desiccant and forms on dehydrogenase enzyme activity. Among all the treatments T_3 recorded highest dehydrogenase enzyme activity (0.440 OD value), whereas the lowest enzyme activity was observed in T_{14} (0.142 OD value) at the end of storage period. With increase in electrolyte leakage in seeds the viability and vigour of the seed also decreased which has led to decrease in dehydrogenase enzyme activity in seeds during the storage.

Table 1: Effect of packaging materials, desiccant and forms on germination (%) and seed ling dry weight (mg) in groundnut variety G2-52

Treatments		Germination					Seedling dry weight				
		Months after storage					Months after storage				
		Initial month	2nd month	4th month	6th month	8th month	Initial month	2nd month	4th month	6th month	8th month
Packaging materials (P)	(P_1)	93.00 (74.68)	91.17 (72.74)	87.42 (69.33)	83.67 (66.28)	80.50 (63.87)	368.8	351.6	332.2	317.8	277.2
	(P_2)	93.00 (74.68)	84.92 (67.21)	75.42 (60.32)	71.92 (58.03)	66.50 (54.67)	368.8	331.3	288.2	257.1	191.2
	(P_3)	93.00 (74.68)	90.50 (72.10)	86.08 (68.18)	81.58 (64.64)	78.25 (62.25)	368.8	346.4	320.4	303.3	260.8
	(P_4)	93.00 (74.68)	83.67 (66.19)	68.00 (55.61)	64.25 (53.31)	58.33 (49.81)	368.8	316.4	270.5	218.1	157.2
	Mean	93.00 (74.68)	87.56 (69.56)	79.23 (63.36)	75.35 (60.56)	70.90 (57.65)	368.8	336.4	302.8	274.1	221.6
	SE m±	0.32	0.38	0.57	0.54	0.45	2.58	4.04	3.75	3.70	3.20
	CD (0.01)	NS	1.03	1.55	1.48	1.23	NS	11.03	10.24	10.10	8.73
Desiccant (D)	(D_0)	93.00 (74.68)	86.96 (69.01)	78.17 (62.56)	74.00 (59.59)	69.46 (56.67)	368.8	333.2	295.9	266.1	209.8
	(D_1)	93.00 (74.68)	88.17 (70.11)	80.29 (64.16)	76.71 (61.54)	72.33 (58.63)	368.8	339.7	309.8	282.1	233.4
	Mean	93.00 (74.68)	87.56 (69.56)	79.23 (63.36)	75.35 (60.56)	70.90 (57.65)	368.8	336.4	302.8	274.1	221.6
	SE m±	0.23	0.05	0.08	0.08	0.06	1.83	0.58	0.54	0.53	0.46
	CD (0.01)	NS	0.149	0.224	0.213	0.178	NS	NS	1.47	1.45	1.26
Forms (F)	(F_1)	93.00 (74.68)	88.33 (70.18)	81.04 (64.53)	77.00 (61.62)	72.75 (58.80)	368.8	338.9	307.1	281.21	230.1
	(F_2)	93.00 (74.68)	86.79 (68.93)	77.42 (62.19)	73.71 (59.51)	69.04 (56.50)	368.8	333.9	298.5	267.0	213.1
	Mean	93.00 (74.68)	87.56 (69.56)	79.23 (63.36)	75.35 (60.56)	70.90 (57.65)	368.8	336.4	302.8	274.1	221.6
	SE m±	0.23	0.05	0.08	0.08	0.06	1.83	0.58	0.54	0.53	0.46
	CD (0.01)	NS	0.149	0.224	0.213	0.178	NS	NS	NS	1.45	1.26
Interaction	P_1D_0	93.00	90.50	86.00	81.50	78.33	368.86	346.7	319.7	302.7	256.8

(PXD)		(74.68)	(72.06)	(68.07)	(64.56)	(62.28)					
	P_1D_1	93.00 (74.68)	91.83 (73.42)	88.83 (70.59)	85.83 (67.99)	82.67 (65.46)	368.86	356.5	344.6	333.0	297.6
	P_2D_0	93.00 (74.68)	84.33 (66.73)	74.67 (59.82)	70.67 (57.24)	65.67 (54.16)	368.86	329.4	286.9	255.1	186.8
	P_2D_1	93.00 (74.68)	85.50 (67.70)	76.17 (60.81)	73.17 (58.82)	67.33 (55.18)	368.86	333.1	289.6	259.2	195.7
	P_3D_0	93.00 (74.68)	89.83 (71.45)	85.17 (67.44)	80.17 (63.58)	76.50 (61.02)	368.86	341.4	305.4	289.1	241.4
	P_3D_1	93.00 (74.68)	91.17 (72.74)	87.00 (68.92)	83.00 (65.70)	80.00 (63.48)	368.86	351.4	335.4	317.4	280.2
	P_4D_0	93.00 (74.68)	83.17 (65.81)	66.83 (54.90)	63.67 (52.97)	57.33 (49.23)	368.86	315.2	271.4	217.7	154.2
	P_4D_1	93.00 (74.68)	84.17 (66.56)	69.17 (56.33)	64.83 (53.66)	59.33 (50.39)	368.86	317.7	269.6	218.6	160.3
	Mean	93.00 (74.68)	87.56 (69.56)	79.23 (63.36)	75.35 (60.56)	70.90 (57.65)	368.86	336.4	302.8	274.1	221.6
	SE m±	0.45	0.22	0.33	0.31	0.27	3.65	2.33	2.16	2.13	1.84
	CD(0.01)	NS	NS	NS	NS	NS	NS	NS	5.91	5.83	5.04
Interaction (P x F)	P_1F_1	93.00 (74.68)	91.33 (72.90)	87.67 (69.53)	84.17 (66.69)	81.17 (64.37)	368.86	352.8	335.3	323.0	282.2
	P_1F_2	93.00 (74.68)	91.00 (72.58)	87.17 (69.14)	83.17 (65.87)	79.83 (63.37)	368.86	350.4	329.1	312.7	272.2
	P_2F_1	93.00 (74.68)	86.50 (68.47)	77.67 (61.82)	74.50 (59.68)	69.50 (56.50)	368.86	336.6	292.6	266.0	203.3
	P_2F_2	93.00 (74.68)	83.33 (65.96)	73.17 (58.82)	69.33 (56.38)	63.50 (52.83)	368.86	325.9	283.8	248.2	179.2
	P_3F_1	93.00 (74.68)	90.67 (72.27)	86.33 (68.40)	82.00 (64.95)	78.83 (62.66)	368.86	347.3	323.7	308.1	266.8
	P_3F_2	93.00 (74.68)	90.33 (71.92)	85.83 (67.96)	81.17 (64.32)	77.67 (61.84)	368.86	345.5	317.0	298.5	254.8
	P_4F_1	93.0 (74.68)	84.83 (67.09)	72.50 (58.38)	67.33 (55.16)	61.50 (51.65)	368.9	319.1	276.9	227.5	168.2
	P_4F_2	93.0 (74.68)	82.50 (65.28)	63.50 (52.85)	61.17 (51.46)	55.17 (47.97)	368.9	313.8	264.2	208.7	146.3
	Mean	93.00 (74.68)	87.56 (69.56)	79.23 (63.36)	75.35 (60.56)	70.90 (57.65)	368.86	336.4	302.8	274.1	221.6
	SE m±	0.39	0.22	0.33	0.31	0.26	3.16	2.33	4.59	2.13	1.84
	CD (0.01)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (D x F)	D_0F_1	93.00 (74.68)	87.75 (69.64)	80.08 (63.79)	75.75 (60.70)	71.17 (57.70)	368.86	335.9	299.4	272.6	217.2
	D_0F_2	93.00 (74.68)	86.17 (68.38)	76.25 (61.32)	72.25 (58.48)	67.75 (55.65)	368.86	330.4	292.3	259.7	202.3
	D_1F_1	93.00 (74.68)	88.92 (70.73)	82.00 (65.27)	78.25 (62.55)	74.33 (59.89)	368.86	342.0	314.8	289.7	243.0
	D_1F_2	93.00 (74.68)	87.42 (69.48)	78.58 (63.06)	75.17 (60.54)	70.33 (57.36)	368.86	337.4	304.7	274.4	223.9
	Mean	93.00 (74.68)	87.56 (69.56)	79.23 (63.36)	75.35 (60.56)	70.90 (57.65)	368.86	336.4	302.8	274.1	221.6
	SE m±	0.32	0.11	0.16	0.15	0.13	2.58	1.17	1.08	1.07	0.92
	CD (0.01)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (P x D x F)	T_1 - $P_1D_0F_1$	93.00 (74.68)	90.67 (72.22)	86.33 (68.34)	82.00 (64.93)	78.67 (62.50)	368.8	348.1	321.9	305.8	261.3
	T_2 - $P_1D_0F_2$	93.00 (74.68)	90.33 (71.91)	85.67 (67.80)	81.00 (64.19)	78.00 (62.06)	368.8	345.3	317.5	299.6	252.3
	T_3 - $P_1D_1F_1$	93.00 (74.68)	92.00 (73.59)	89.00 (70.71)	86.33 (68.44)	83.67 (66.24)	368.8	357.5	348.6	340.2	303.1
	T_4 - $P_1D_1F_2$	93.00 (74.68)	91.67 (73.25)	88.67 (70.47)	85.33 (67.54)	81.67 (64.68)	368.8	355.6	340.6	325.8	292.2
	T_5 - $P_2D_0F_1$	93.00 (74.68)	85.67 (67.76)	77.00 (61.36)	73.67 (59.14)	68.33 (55.78)	368.8	335.2	290.8	263.0	197.3
	T_6 - $P_2D_0F_2$	93.00 (74.68)	83.00 (65.69)	72.33 (58.29)	67.67 (55.35)	63.00 (52.54)	368.8	323.7	283.0	247.2	176.4
	T_7 - $P_2D_1F_1$	93.00 (74.68)	87.33 (69.17)	78.33 (62.28)	75.33 (60.23)	70.67 (57.23)	368.8	338.1	294.5	269.1	209.3
	T_8 - $P_2D_1F_2$	93.00 (74.68)	83.67 (66.22)	74.00 (59.35)	71.00 (57.42)	64.00 (53.13)	368.8	328.2	284.7	249.3	182.1
	T_9 - $P_3D_0F_1$	93.00 (74.68)	90.00 (71.62)	85.33 (67.63)	80.67 (63.95)	77.00 (61.35)	368.8	342.3	309.1	294.7	244.3
	T_{10} -$P_3D_0F_2$	93.00	89.67	85.00	79.67	76.00	368.8	340.5	301.8	283.4	238.5

		(74.68)	(71.28)	(67.24)	(63.21)	(60.69)					
	T11 -P3D1F1	93.00 (74.68)	91.33 (72.92)	87.33 (60.16)	83.33 (65.96)	80.67 (63.96)	368.8	352.3	338.4	321.4	289.3
	T12 -P3D1F2	93.00 (74.68)	91.00 (72.56)	86.67 (68.67)	82.67 (65.43)	79.33 (62.99)	368.8	350.6	332.3	313.5	271.2
	T13 -P4D0F1	93.00 (74.68)	84.67 (66.96)	71.67 (57.84)	66.67 (54.77)	60.67 (51.16)	368.8	318.2	275.9	226.9	166.1
	T14 -P4D0F2	93.00 (74.68)	81.67 (64.65)	62.00 (51.95)	60.67 (51.16)	54.00 (47.29)	368.8	312.3	267.0	208.5	142.3
	T15 -P4D1F1	93.00 (74.68)	85.00 (67.22)	73.33 (58.91)	68.00 (55.56)	62.33 (52.14)	368.8	320.1	277.9	228.2	170.4
	T16 -P4D1F2	93.00 (74.68)	83.33 (65.91)	65.00 (53.75)	61.67 (51.76)	56.33 (48.64)	368.8	315.3	261.3	209.0	150.3
	Mean	93.00 (74.68)	87.56 (69.56)	79.23 (63.36)	75.35 (60.56)	70.90 (57.65)	368.8	336.4	302.8	274.1	221.6
	SE m±	0.64	0.436	0.654	0.623	0.520	5.16	4.66	4.32	4.26	3.69
	CD (0.01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

- Figures in parenthesis indicates arcsine transformed values.
- Packaging materials (P): P_1- PICS Bag, P_2- HDPE Bag, P_3- Polythene bag, P_4- Gunny bag.
- Desiccant- D_0- Without Zeolite beads, D_1-With Zeolite beads.
- Seed forms (F): F_1-Pod, F_2-Kernel

Table 2: Effect of packaging materials, desiccant and forms on electrical conductivity (dS/m) and dehydrogenase enzyme activity (OD value) in groundnut variety G2-52.

Treatments		**Electrical conductivity**					**Dehydrogenase enzyme activity**				
		Months after storage					**Months after storage**				
		Initial month	**2nd month**	**4th month**	**6th month**	**8th month**	**Initial month**	**2nd month**	**4th month**	**6th month**	**8th month**
Packaging materials (P)	(P1)	0.208	0.255	0.371	0.524	0.621	0.772	0.707	0.618	0.586	0.430
	(P2)	0.208	0.323	0.514	0.639	0.769	0.772	0.640	0.462	0.429	0.241
	(P3)	0.208	0.275	0.420	0.558	0.678	0.772	0.691	0.569	0.560	0.365
	(P4)	0.208	0.378	0.607	0.738	0.902	0.772	0.602	0.388	0.346	0.184
	Mean	0.208	0.308	0.478	0.615	0.743	0.772	0.660	0.509	0.480	0.305
	SE m±	0.002	0.002	0.002	0.002	0.002	0.006	0.009	0.007	0.006	0.004
	CD (0.01)	NS	0.006	0.007	0.005	0.005	NS	0.024	0.019	0.018	0.011
Desiccant (D)	(D0)	0.208	0.320	0.507	0.640	0.778	0.772	0.648	0.482	0.456	0.268
	(D1)	0.208	0.295	0.449	0.590	0.708	0.772	0.672	0.536	0.505	0.342
	Mean	0.208	0.308	0.478	0.615	0.743	0.772	0.660	0.509	0.480	0.305
	SE m±	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	CD (0.01)	NS	0.002	0.003	0.002	0.002	NS	0.004	0.003	0.003	0.002
Forms (F)	(F1)	0.208	0.298	0.460	0.596	0.720	0.772	0.667	0.525	0.499	0.322
	(F2)	0.208	0.317	0.496	0.634	0.765	0.772	0.654	0.494	0.462	0.288
	Mean	0.208	0.308	0.478	0.615	0.743	0.772	0.660	0.509	0.480	0.305
	SE m±	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002
	CD (0.01)	NS	0.002	0.003	0.002	0.002	NS	NS	0.003	0.003	0.006
Interaction (PXD)	P1D0	0.208	0.275	0.410	0.559	0.679	0.772	0.688	0.575	0.550	0.359
	P1D1	0.208	0.235	0.331	0.489	0.564	0.772	0.726	0.661	0.622	0.501
	P2D0	0.208	0.330	0.525	0.653	0.779	0.772	0.635	0.452	0.417	0.236
	P2D1	0.208	0.317	0.503	0.625	0.760	0.772	0.645	0.472	0.442	0.247
	P3D0	0.208	0.292	0.470	0.597	0.733	0.772	0.672	0.522	0.518	0.296
	P3D1	0.208	0.258	0.371	0.520	0.624	0.772	0.711	0.617	0.602	0.435
	P4D0	0.208	0.384	0.624	0.753	0.920	0.772	0.597	0.380	0.340	0.180
	P4D1	0.208	0.373	0.591	0.724	0.883	0.772	0.608	0.397	0.353	0.187
	Mean	0.208	0.308	0.478	0.615	0.743	0.772	0.660	0.509	0.480	0.305
	SE m±	0.001	0.001	0.001	0.001	0.001	0.003	0.005	0.004	0.004	0.002
	CD(0.01)	NS	0.004	0.004	0.003	0.003	NS	NS	0.011	0.010	0.007
Interaction (P x F)	P1F1	0.208	0.249	0.361	0.515	0.603	0.772	0.711	0.629	0.604	0.451
	P1F2	0.208	0.261	0.381	0.533	0.640	0.772	0.703	0.607	0.569	0.409
	P2F1	0.208	0.312	0.485	0.615	0.750	0.772	0.653	0.482	0.457	0.257
	P2F2	0.208	0.335	0.543	0.663	0.789	0.772	0.627	0.442	0.402	0.226
	P3F1	0.208	0.270	0.410	0.549	0.660	0.772	0.695	0.582	0.575	0.377
	P3F2	0.208	0.279	0.431	0.568	0.696	0.772	0.688	0.557	0.546	0.354
	P4F1	0.208	0.363	0.584	0.704	0.869	0.772	0.608	0.406	0.362	0.202
	P4F2	0.208	0.394	0.631	0.773	0.935	0.772	0.597	0.371	0.331	0.165
	Mean	0.208	0.308	0.478	0.615	0.743	0.772	0.660	0.509	0.480	0.305
	SE m±	0.001	0.001	0.001	0.001	0.001	0.003	0.005	0.004	0.004	0.002
	CD(0.01)	NS	0.004	0.004	0.003	0.003	NS	NS	NS	NS	NS
Interaction (D x F)	D0F1	0.208	0.311	0.485	0.618	0.758	0.772	0.654	0.498	0.472	0.286
	D0F2	0.208	0.330	0.530	0.662	0.797	0.772	0.641	0.467	0.440	0.249

	D_1F_1	0.208	0.286	0.435	0.573	0.683	0.772	0.679	0.551	0.526	0.357
	D_1F_2	0.208	0.305	0.462	0.606	0.733	0.772	0.666	0.522	0.483	0.328
	Mean	0.208	0.308	0.478	0.615	0.743	0.772	0.660	0.509	0.480	0.305
	SE m±	0.001	0.001	0.001	0.001	0.001	0.002	0.003	0.002	0.002	0.001
	CD (0.01)	NS	NS	0.002	0.002	0.001	NS	NS	NS	NS	NS
Interaction (P x D x F)	T_1 - $P_1D_0F_1$	0.208	0.270	0.395	0.550	0.666	0.772	0.692	0.588	0.569	0.392
	T_2 - $P_1D_0F_2$	0.208	0.280	0.425	0.568	0.691	0.772	0.683	0.562	0.531	0.326
	T_3 - $P_1D_1F_1$	0.208	0.227	0.326	0.480	0.539	0.772	0.730	0.670	0.639	0.510
	T_4 - $P_1D_1F_2$	0.208	0.242	0.336	0.498	0.588	0.772	0.723	0.652	0.606	0.492
	T_5 - $P_2D_0F_1$	0.208	0.315	0.495	0.625	0.760	0.772	0.648	0.472	0.442	0.252
	T_6 - $P_2D_0F_2$	0.208	0.345	0.555	0.680	0.798	0.772	0.621	0.431	0.392	0.220
	T_7 - $P_2D_1F_1$	0.208	0.308	0.475	0.605	0.739	0.772	0.658	0.492	0.471	0.262
	T_8 - $P_2D_1F_2$	0.208	0.325	0.530	0.645	0.780	0.772	0.632	0.452	0.412	0.231
	T_9 - $P_3D_0F_1$	0.208	0.288	0.460	0.588	0.720	0.772	0.675	0.541	0.527	0.321
	T_{10} -$P_3D_0F_2$	0.208	0.295	0.480	0.605	0.745	0.772	0.669	0.521	0.509	0.306
	T_{11} -$P_3D_1F_1$	0.208	0.252	0.360	0.510	0.601	0.772	0.715	0.632	0.618	0.452
	T_{12} -$P_3D_1F_2$	0.208	0.263	0.381	0.530	0.648	0.772	0.706	0.601	0.582	0.418
	T_{13} -$P_4D_0F_1$	0.208	0.370	0.588	0.710	0.885	0.772	0.602	0.399	0.351	0.199
	T_{14} -$P_4D_0F_2$	0.208	0.398	0.660	0.796	0.955	0.772	0.592	0.361	0.328	0.161
	T_{15} -$P_4D_1F_1$	0.208	0.355	0.580	0.698	0.852	0.772	0.613	0.412	0.372	0.205
	T_{16} -$P_4D_1F_2$	0.208	0.390	0.601	0.750	0.914	0.772	0.602	0.381	0.333	0.169
	Mean	0.208	0.31	0.478	0.615	0.743	0.772	0.660	0.509	0.480	0.305
	SE m±	0.002	0.003	0.003	0.002	0.002	0.007	0.010	0.008	0.006	0.005
	CD (0.01	NS	NS	0.008	0.006	0.006	NS	NS	NS	NS	NS

- Packaging materials (P): P_1- PICS Bag, P_2- HDPE Bag, P_3- Polythene bag, P_4- Gunny bag.
- Desiccant- D_0-Without Zeolite beads, D_1-With Zeolite beads.
- Seed forms (F): F_1-Pod, F_2-Kernel.

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